PRODUCING AVOCADO IN HAWAII

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University of Hawaii, Cooperative Extension Service

Circular 382

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The avocado is among the earliest of the fruit trees brought to the Hawaiian Islands. Records indicate introduction early in the nineteenth century by Don Francisco de Paulo Marin. By 1855 trees which are believed to be of Guatemalan origin had become quite common on Oahu and had spread to the other islands.

Avocado ranks third among fruits commercially produced for fresh consumption and fifth among all orchard crops in Hawaii. Many farm and city homes have trees in the yard to supply family needs. The largest commercial planting ever established in the Hawaiian Islands was that of the Hawaiian Avocado Company near Waimea, Oahu. The largest acreage in avocados was reached in 1941 with 500 acres planted, but since then has declined. Total acreage in the territory is now estimated at 200 acres.

All the fruits produced are consumed in Hawaii. Records show that heaviest production of fruits occurs during the months of February—April, with lowest production in June. At present the center of production is in the Kona district of Hawaii. Many of the avocados marketed from this district are of seedling origin.

As early as 1904–1907, the Hawaii Agricultural Experiment Station made test shipments of avocados to West Coast cities as far north as Vancouver and to other cities including Chicago, New York, and Washington. In 1910 however, the Mediterranean fruit fly became established in Hawaii, and to prevent its introduction to the mainland federal and state quarantines were imposed against fresh fruit shipments from the Islands.

Successful fruit sterilization treatments developed to destroy the Mediterranean fruit fly or the Oriental fruit fly in other fruits have not proven satisfactory for avocado. The Agricultural Research Service Fruit Fly Laboratory, in cooperation with the Hawaii Agricultural Experiment Station, is continuing research on this problem. Should a satisfactory treatment be developed the avocado may become one of the major fruit crops grown for export.

The Division of Marketing of the Board of Agriculture and Forestry has set up export restrictions. Avocado must be graded Hawaii No. 1 or better, to be shipped. In addition, the minimum oil content of the avocados in any lot must be 12 percent or higher. Further information on characteristics of each grade can be obtained from the above agency.

RACES

The avocado *(Persea americana)* is represented in Hawaii by three races and by hybrid seedlings between them: West Indian, Guatemalan, and Mexican. Florida Extension Bulletin No. 129 describes the three races as follows:

"The West Indian race is native to the lowlands of Central and South America, and was introduced into the West Indies by the early Spaniards. Trees of this race are the most sensitive to cold. The skin of the fruit is always smooth and leathery, and in green-skinned varieties is always a yellowish-green rather than a dark green. The seed is comparatively large and often loose in the cavity; the seed coats are usually separated; and the cotyledons are rough on the surface. The fruit stems are short.

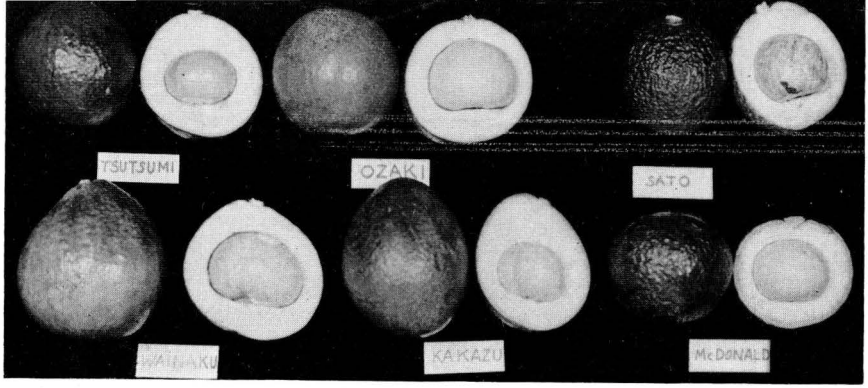


FIGURE 1. HAWAIIAN VARIETIES

"The Guatemalan race is native to the highlands of Central America and was unknown in Florida until after 1900. Although native to Ecuador, Nicaragua and Mexico also, most of the importations of seeds and scions have been from Guatemala, and hence the race name. The trees are much more cold–resistant than those of the West Indian race, and the newly flushed foliage is more frequently reddish or bronze in color, instead of green. The skin of the fruit is always thick and woody and usually decidedly rough. In green–fruited varieties, usually the green is a dark shade. The seed usually is small and fits tightly in the cavity; the seed coats adhere closely to each other and to the seed, and the cotyledon surfaces are smooth. The fruit usually is borne on long fruit stems.

"The Mexican race is native to the highlands of Mexico and of the whole Andean cordillera as far as Chile. Leaves and young fruit possess a characteristic odor of anise when crushed. The fruit is smaller than that of the other races, rarely exceeding one pound and in most varieties averaging eight ounces. The skin is nearly always quite thin and smooth. The seed is comparatively large; the seed coats are thin and either separated or adhering to the cotyledons and the surface of the cotyledons is smooth." (Note: recent publications designate the Mexican "race" as a variety.)

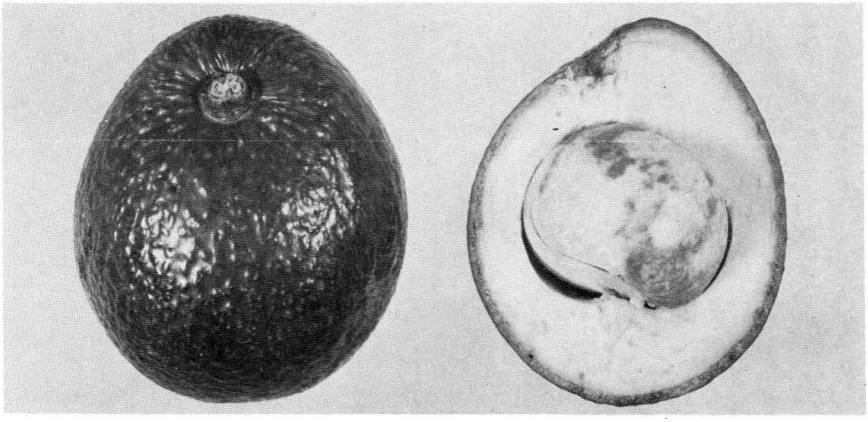
VARIETIES

The Hawaii Agricultural Experiment Station had as many as 65 Hawaiian varieties under observation in 1911. The most famous is the McDonald, which is still being grown at the Poamoho and Kona branch stations. The McDonald is credited as the parent of some of our outstanding seedling avocados of today. The most important of these is the Beardslee. Other varieties whose lineage is derived from the McDonald are the Nutmeg, Holt, Wilder, Case, the Lehua and Ilialu.

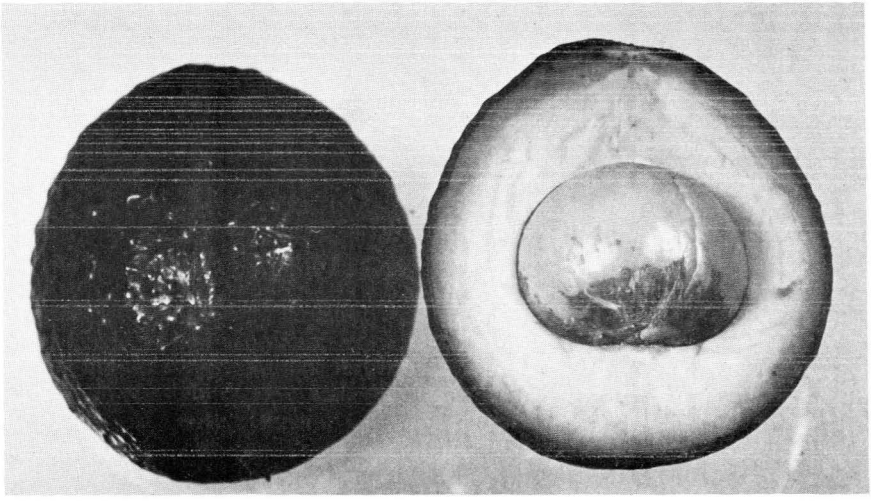
Most varieties imported into the territory have adapted themselves well Among them are the Fuerte, Nabal, Linda, Panchoy, Itzamna, Lulu and Kaguah. The season an avocado variety comes into bearing varies somewhat with the elevation.

ORIGIN AND DESCRIPTION OF VARIETIES

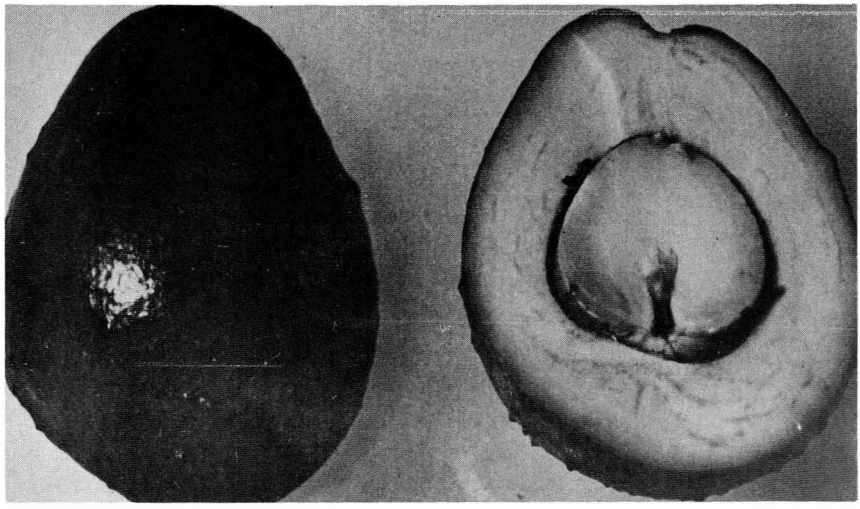
THE MCDONALD developed from a seed imported from Guatemala by Admiral Beardslee in 1891. The tree was planted at 1402 Punahou Street by Judge Wiedman. Fruit characteristics: *form,* spherical; *color,* dark purple on ripening: *surface,* rough and warty; *rind,* thick and granular; *weight,* 8–16 oz.; *flesh,* yellow ranging to green toward rind; *flavor,* rich and nutty; *seed,* large; *season,* May to August (see figure 1).



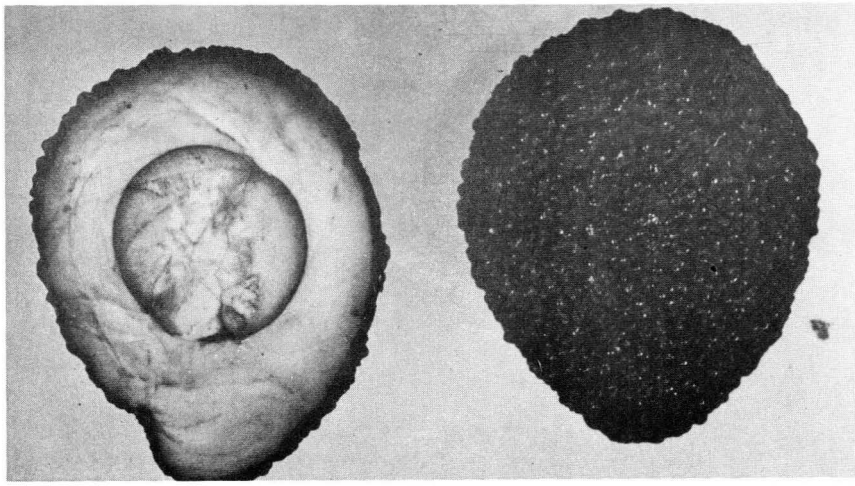
THE BEARDSLEE was grown from a seed of the McDonald. It was planted Dec. 18, 1911, by L. C. Ables, at 1627 Kewalo St., Honolulu. Hence it is frequently called the Ables. The variety was named in 1919 in honor of Admiral Beardslee. Fruit characteristics: *form,* oval; *color,* green when ripe; *surface,* round; *rind,* thick, granular, and woody; *weight* 1½–2½ pounds; *flesh,* yellow tinged with green next to rind; *flavor,* rich and nutty; *seed,* medium to large; *season,* from September to December. Oil content, above 12 percent (above).



THE NABAL is a Guatemalan variety introduced by F. W. Popenoe from Antigua, Guatemala, in 1917. It was brought to Hawaii by the Hawaii Agricultural Experiment Station in 1919 as one of 22 varieties received from the Agricultural Research Service. The variety is a heavy bearer, yielding as much as 1500 pounds in some seasons. Fruit characteristics: *form,* almost spherical; *color,* green; *surface,* nearly smooth; *rind,* medium thick; *weight,* 1–1½ pounds; *flesh,* yellow; *flavor,* good; *seed,* medium size; *season,* January–July (above).

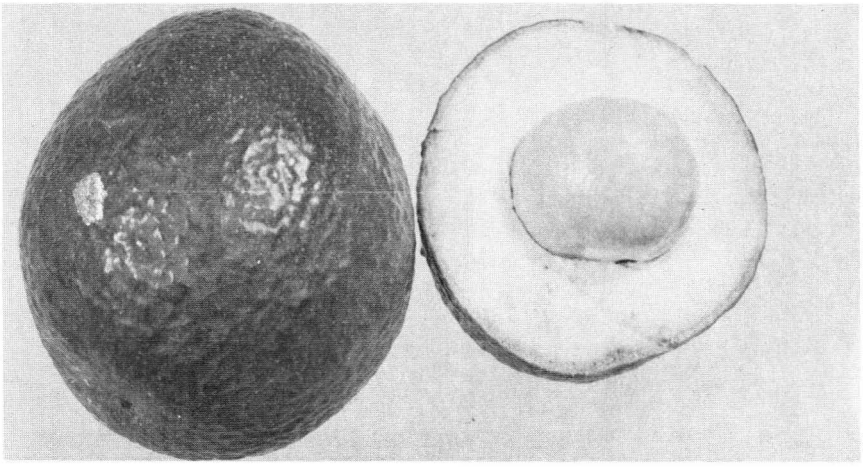


THE FUERTE is believed to be a seedling of Guatemalan × Mexican parentage. It was introduced into the U. S. in 1911 from Atlixco, Mexico, by Carl Schmidt. It was brought to Hawaii by the Hawaii Agricultural Experiment Station in 1921. W. D. Baldwin, of Haiku, Maui, also may have brought this variety in about the same time. The variety is not propagated extensively in the territory, probably because there is a local preference for larger fruits. Fruit characteristics: *form,* pyriform; *color,* green; *surface,* slightly pebbled; *rind,* thin and pliable; *weight,* 10–16 ounces; *flesh,* creamy yellow; *flavor,* moderately rich; *seed,* medium size; *season,* July–January (above).

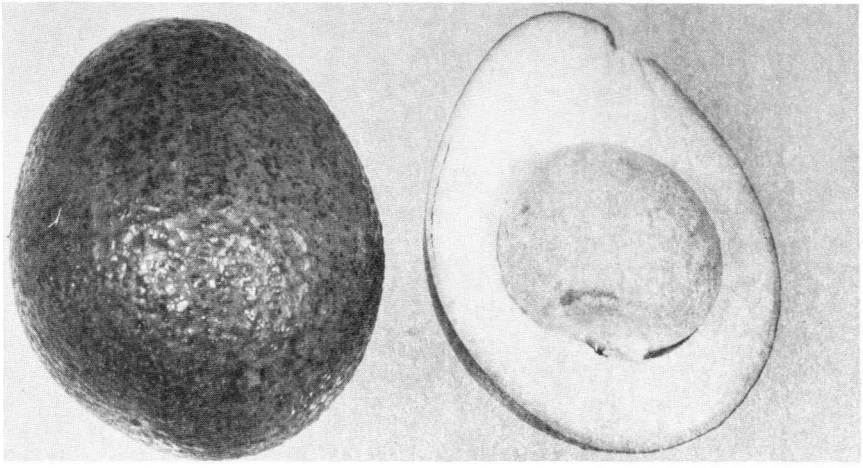


THE HASS (above) is a Guatemalan type grown from seed planted by R. G. Hass at La Habra Heights, California, in 1926. The variety is not propagated extensively in the territory. Fruit characteristics: *form,* pyriform; *color,* dark

purple when ripe; *surface,* pebbled; *rind,* thin for Guatemalan; *weight,* 6–10 ounces; *flesh,* yellow; *flavor,* rich and nutty; *seed,* small to medium; *season,* January–March. Oil content above 20 percent.



THE LINDA is a Guatemalan variety introduced by E. E. Night to California in 1914. There is no record of its first introduction to the territory. The variety is well distributed throughout the Islands, however. The tree is a regular bearer with moderate sized crops. Fruit characteristics: *form,* round to oblong; *color,* purple when mature; *surface,* rough; *rind,* thick; *weight,* 1–2½ pounds; *flesh,* light yellow tinged with green next to rind; *flavor,* fair; *seed,* small; *season,* March–May (above).



THE ANAHEIM is a seedling from E. C. Dutton planted at Anaheim, California, in 1910. *Fruit–form,* elliptical; *color,* green; *surface,* rough; *rind,* medium–thick; *weight,* 1–2 pounds; *flesh,* light yellow; *flavor,* good; *seed,* small. *Season,* May–July.

THE PANCHOY is a Guatemalan variety introduced into the U. S. from Antigua, Guatemala. The variety is well distributed throughout the Territory. It is not being grown to any extent in commercial plantings, however. *Fruit–form,* pyriform; *color,* green; *surface,* rough; *rind,* thick; *weight,* 18–24 ounces; *flesh,* light yellow; *flavor,* fair. *Seed,* medium. *Season,* April–July (not illus.).

Other varieties which have been introduced and are still being grown to a limited extent are the Kanola, Manik, Kashlan, Itzamna, Kaguah and Pollock. Hawaiian varieties which are being maintained are Seyde, Hulumanu, and Ilialu.

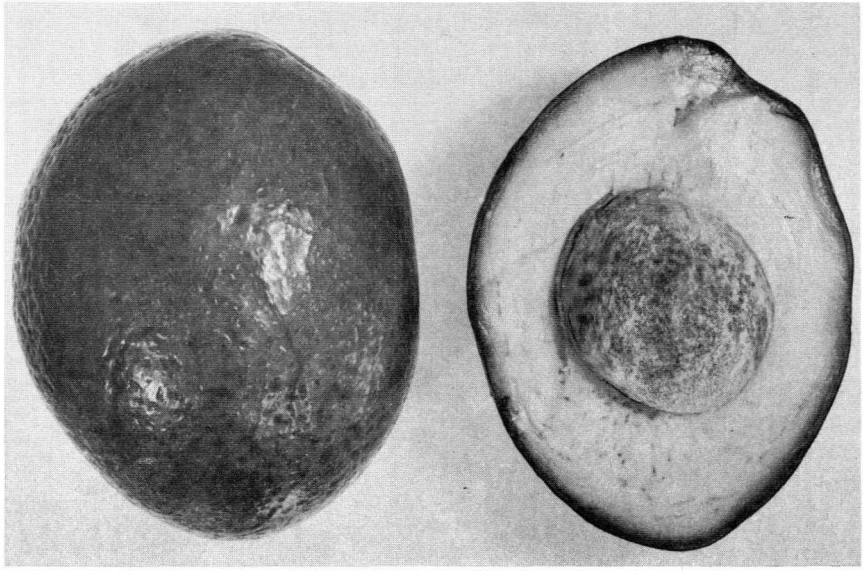
Some of the better avocados from the Hawaiian Avocado Company's plantings were given the name *Haley* because the orchard was under the management of the Wm. R. Haley family. Hence, there are several entirely different types of avocados which bear that name today.

Newly discovered Hawaiian seedlings showing promise are:

Kahaluu. *Form,* rounded obovate; *weight,* 12–16 ounces; *color,* green; *rind,* smooth and thin; *seed,* medium; *season,* late fall to early winter; *type,* Guatemalan (see illustration, below).

Tsutsumi. *Form,* almost spherical; *weight,* 8–16 ounces; *color,* purple; *rind,* medium thickness; *seed,* medium; *season,* spring; *type,* Guatemalan (see figure 1).

Tanaka. *Form,* obovate; *weight,* 24 ounces; *color,* green; *rind,* medium thick; *seed,* small; *season,* spring–summer; *type,* Guatemalan. Oil content above 14 percent.



FLOWERING BEHAVIOR

All varieties can be placed in two groups with reference to the normal time and sequence of the opening and closing of the flowers. In group **A,** the first opening of the flower occurs in the forenoon during which time the pistil is receptive but pollen is not discharged. In group **B,** the flower opens for the first

time in the afternoon. In both groups a second opening of the flowers occurs, at which time the pistil is no longer receptive but the pollen is shed. An intervening period of 12 to 36 hours separates the time of maturity of the sex organs of each flower.

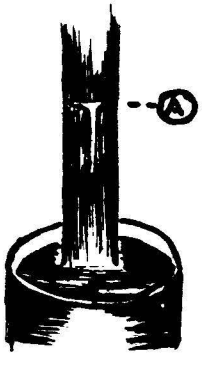
Studies have been made regarding the behavior of avocado varieties growing in the Hawaiian Islands relative to time of opening of flowers. The findings are in accord with those of workers on the mainland. The recommendation however is that there are enough trees of both **A** and **B** types in most areas of the Islands to permit adequate cross pollination. Physiological and environmental factors seem to be responsible for poor set of fruit in most instances.

PROPAGATION

The avocado is propagated by various methods of grafting. It has not been found practical to produce new plants by cuttings or layering.

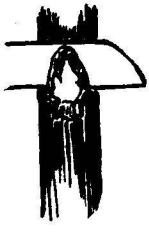
BUDDING

In the early stages of the industry most nursery stock was produced by budding young seedlings. The shield bud method (using the **T**–slot) was found most successful. Like most other plants the avocado is most easily budded during the flush season (the season of most rapid growth). A seedling 3/8–inch in diameter is ideal for budding. Considerable care must be taken to select the bud wood with plump, mature buds that are not too soft and green and at the same time not too old and woody. The former rarely survive and the latter often fail. When possible, bud wood should be obtained from sources that are certified free from virus diseases.



1.

Stock or seedling prepared for budding. Select a section of stock smooth and free of buds. Make a **T** by cutting through the bark. Loosen bark at point **A**.



2.

Remove plump bud from scion, taking a small portion of wood with bud to strenthen it for pushing in **T** slot. Cutting down the scion makes for a strong, smooth edge on the shield, which is needed when the bud is to be forced under the bark.

3.

Raise corners of T slot and slip bud in until the entire chip is covered.

4.

Bud in place, ready for wrapping and waxing. A piece of raffia or strip of plastic is ideal for wrapping the bud. Do not cover the tip of the bud, as this may prevent shoot development. A slight reduction of the growing terminal of the stock should be made to encourage development of the bud.

The Side Wedge Graft

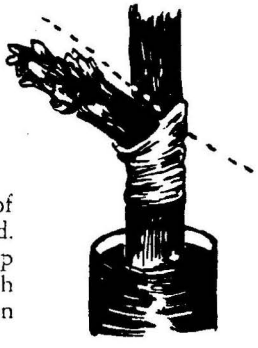
The side wedge graft method is the most popular means of propagating avocado for several reasons: (1) less skill is required in selection of scion wood; (2) it is easier to make the union and a greater exposure of cambium tissue is possible; (3) it is possible to set the side wedge graft when the bark is too tight for budding; (4) in this method part of the growing top of the stock is retained to nourish the root system until the new scion has enough leaves to take over.

1.

A diagonal cut is made in the seedling stock 3 or 4 inches above the soil level.

2.

Scion is prepared by making a wedge–shaped cut for inserting into the stock. Bevel should be slightly longer on the side to be placed against the stock.

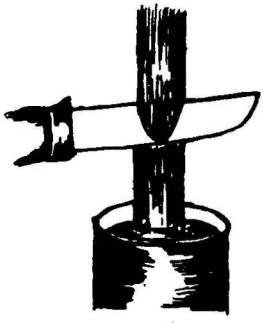


3.

Scion in place, with cambium tissues of both scion and stock perfectly matched. Ready for tying and waxing. The top should not be removed until scion growth starts; then remove the top at the broken line.

Whip Graft

The whip graft makes the fastest union and allows for the greatest exposure of cambium; however, the technique is somewhat exacting and does require removal of the entire top of the seedling.



1.

From a point 3 inches above the soil line, pull the knife upward so that a smooth, diagonal cut 1½ inches long is made on the stock.

2.

Place knife at × and cut (do not split) the stock about ½–inch downward and parallel to stock.

3.

Preparing scion: a diagonal cut is made, and a half-inch vertical cut is made in the open diagonal surface.

4.

Place scion on stock and press downward until the vertical cuts lock firmly. Wrap and tie with raffia and wax.

FERTILIZATION

Trees should be kept in a thrifty condition by application of fertilizer as needed. A tree with a heavy crop of fruits will require more fertilizer than a tree with a light crop. A complete fertilizer containing the three major elements, nitrogen (N), phosphorus (P), and potassium (K), is usually used. An example of such a fertilizer is the General Garden Fertilizer 8–10–8. During the first year, a small grafted tree will be given approximately one pound of fertilizer. The fertilizer is divided into three applications:

At planting time—¼–pound
4 months later—¼–pound
8 months later—½–pound

Usually, an extra handful of super phosphate fertilizer is put at the bottom of the hole and covered with an inch–thick layer of soil at the time of planting.

In the second year, the amount of fertilizer may be 1½–2 times more than the first year. The amount is divided into two or three applications spaced equally apart.

After the second year, a rule–of–thumb method is used as a guide: a tree should be fertilized with a minimum of one pound of fertilizer for every inch diameter of the tree trunk. In many instances however, as in the case of hot and dry areas, or areas where the soil is poor, the amount is doubled so that a tree with a ten–inch diameter trunk will receive twenty pounds for the year. A soil analysis will help you determine the type of fertilizer to use. Usually, a high nitrogen and potash fertilizer such as 10–5–20 is desirable for bearing trees. A county agent should be consulted whenever possible.

PLANTING DISTANCE

Avocadoes are spaced in the orchard at distances ranging between 25 and 35 feet in permanent plantings. Variety is probably one of the principal factors determining distance. For example, Fuerte avocado trees may be spaced about 25 feet apart, while the Beardslee would spaced at a distance of approximately 30–35 feet in the orchard. Some of the other factors which should be considered in determining planting distances between trees are soil, contour, elevation, and rainfall.

DISEASES

Avocado diseases in the territory have never commanded the attention of our scientists to any great extent because of the small part avocados play in our economy. Hence, little can be said to aid the grower. Further, the small grower is not normally equipped to spray economically and effectively. So the recommendations given for the control of a disease are of a general nature, and are ones which have been found effective with other fruits sustaining similar diseases, or which have been recommended in other avocado growing areas.

Among the diseases reported present are Avocado root rot *(Phytophthora cinnamomi)*, Dothiorella Rot *(Botryosphaleria ribis)*, Scab *(Sphaceloma perseae)*, Anthracnose *(Colletotrichum gloeosporioides)* and algal spot *(Cephaleuros virescens)*.

AVOCADO ROOT ROT is a fungus disease and is associated with the so–called decline in avocado orchards. It has been noticed in sections with poor drainage or where you find a combination of poor drainage and poor soil. Since most of our avocado plantings are in areas with good drainage, this disease has not become a very serious problem.

Research workers on the mainland have found that *P. cinnamomi* was found to be present in healthy trees but doing little damage. However, when excessive water was applied, to a point of "waterlogging" the soil, the trees immediately took on the characteristic symptoms of the "decline disease." *Symptoms:* yellow leaves, sparse foliage, wilting of the leaves with slight or no new growth, and a dieback of twigs; eventually the larger branches or the whole tree dies. *Control:* prevention of the conditions conducive to avocado root rot seems to be the best method of control. This may be accomplished by the following means: (1) select a site with good drainage; (2) obtain disease free plants; (3) use resistant rootstocks such as the *Duke* and *Scott* varieties.

ANTHRACNOSE or *Black Spot* is a fungus disease found throughout the Islands. It is seldom noticed until the fruit starts to ripen and is commonly associated with rot organisms that attack overripe or bruised fruits. *Symptoms:* on green–colored fruit, brown or tan colored spots appear; on dark–colored fruit,

a lighter than natural spot appears. If the fruit is kept in a moist atmosphere, pustules of pink spores appear. Other colors may develop depending on the amount of moisture present. The spore masses may spread forming a pink layer over the surface. The rot quickly penetrates the entire body of the fruit and is therefore slightly different from other rots which are usually confined to the surface during the early stages.

Control: copper sprays seem to give satisfactory control of this disease. One of the more common spray materials on hand is basic copper sulfate which is applied at the rate of 3–4 pounds per 100 gallons of water or approximately 2½–5 tablespoons to a gallon. Spraying should be spaced about a month apart, three months before maturity. Where rainfall is heavy, more frequent application is advisable. Anthracnose can also be controlled by the use of resistant varieties or by restricting plantings to relatively dry areas.

DOTHIORELLA ROT is a fungus disease which has been found on fruit samples in Kamuela and Kona, Hawaii. The disease is probably more widespread than it seems. The disease organism is generally found on dead wood, dead leaf tips, and debris. *Symptoms:* small brown spots which enlarge and envelope large sections of surface areas. Later the flesh is affected and takes on a brown discoloration as well as an offensive odor. The disease may also induce stem-end rot or cause fruit to drop (see fig. 2).

Control: remove dead wood and debris. A manzate (70% wettable powder) spray at the rate of two pounds to 100 gallons of water, or 1–2 tablespoons to a gallon is also suggested. Other fungicides which have been recommended are Captan and Zineb.

SCAB is a fungus disease attacking both fruits and foliage. *Symptoms:* hard, scab–like tissue on fruits, leaves and twigs. *Control:* use resistant varieties such as Itzamna and Linda, or treat with a basic copper spray at the rate of 3–4 pounds to 100 gallons, or 2½–5 tablespoons to a gallon of water.

ALGAL SPOT is a disease found on leaves of trees growing in damp, shady locations. Symptoms: reddish brown cushion–like spots of varying sizes up to ⅛–inch. Control: treat with a basic copper spray at the rate of 3–4 pounds to 100 gallons of water, or 2½–5 tablespoons per gallon (see figure 3).

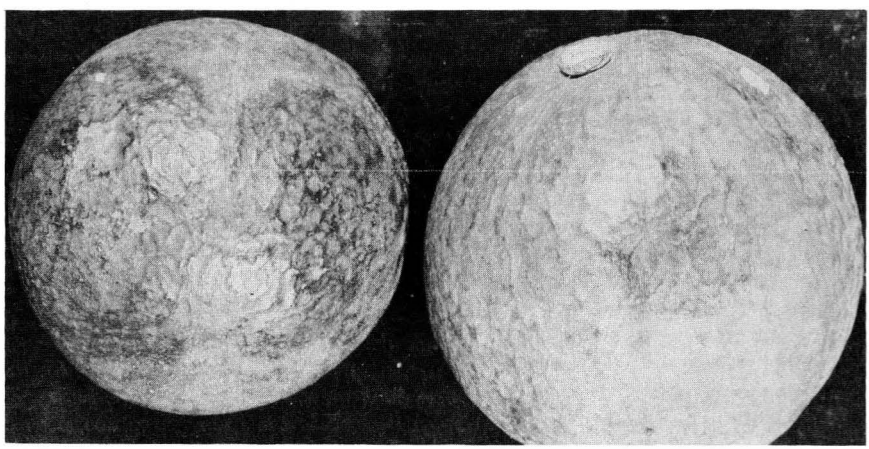


FIGURE 2. DOTHIORELLA ROT

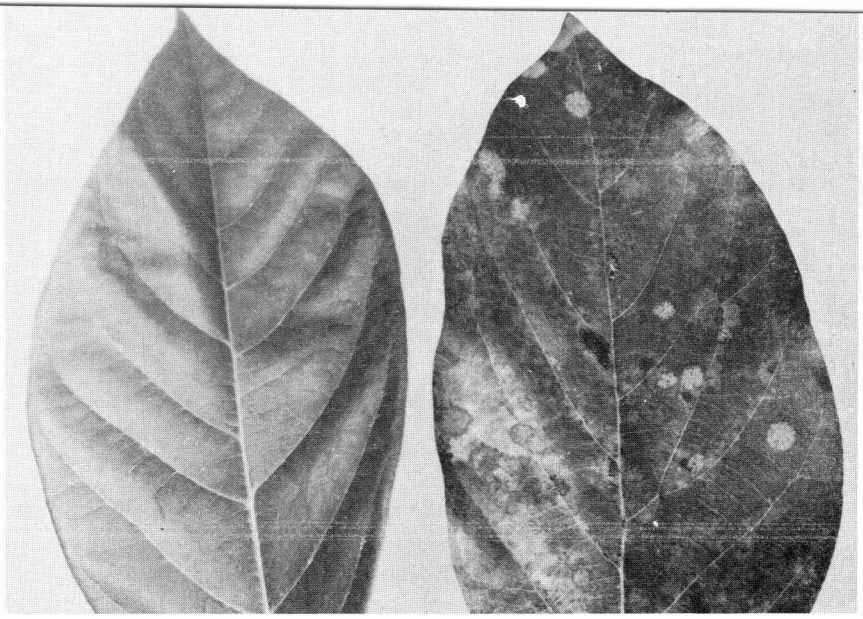


FIGURE 3. ALGAL SPOT. LEFT: HEALTHY LEAF. RIGHT: DISEASED LEAF.

INSECTS

Scales, thrips, beetles, and the fruit flies are the principal insects attacking the avocado. However, since they are not a major problem, spraying or dusting for insect control is not a common practice. There are occasions, however, when a small outbreak of one or more of the above-mentioned pests may attack a planting. In the event control measures are desirable, the following recommendations are suggested:

SCALES. There may be several kinds of scales attacking the avocado. Parasites and predacious insects usually keep them under control. If there is a need to spray, however, a summer oil emulsion such as Volck oil spray may be used at two-week intervals. A good combination is 1–2 gallons of summer oil plus one quart of nicotine sulfate to 100 gallons of water, or 5 tablespoons of summer oil plus one teaspoon of nicotine sulfate to a gallon.

THRIPS. These may cause some damage to fruits. Affected areas turn a grayish brown. Control is obtained by spraying two pounds of 50 percent wettable DDT to 100 gallons of water, or 1½ tablespoons to a gallon. Wettable sulfur should be added to the DDT spray to prevent the development of mites. Usually five pounds and 3–5 tablespoons are added to 100 gallons, or per gallon of spray, respectively.

BEETLES. The Chinese rose bettle is most injurious to young plants. The beetle eats the leaves, often leaving only the veins or skeleton. Control is obtained by spraying two pounds of 50 percent wettable DDT in 100 gallons of water at 7 to 10 day intervals, or 1½ tablespoons to a gallon. Here again wettable sulfur is added to the DDT spray.

FRUIT FLIES. The oriental fruit fly is another pest of avocados. However, the fruit fly does not cause serious fruit damage at present because the parasite *Opius oophilus* Fullaway has the fly under control. Thick rinded varieties are less susceptible to fly damage than those having a thin rind. Fortunately, most of our commercial varieties characteristically have a thick rind.

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